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(71) Applicant *(for all designated States except US)*: **INGERSOLL CUTTING TOOL COMPANY** [US/US]; 505 Fulton Avenue, Rockford, IL 61103-4199 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **JOHNSON, William, Bennett** [US/US]; 3607 Schalck Drive, Rockford, IL 61103 (US).

(74) Agents: **SAMPLES, Kenneth, H.** et al.; Fitch, Even, Tabin & Flannery, Suite 1600, 120 South LaSalle Street, Chicago, IL 60603 (US).

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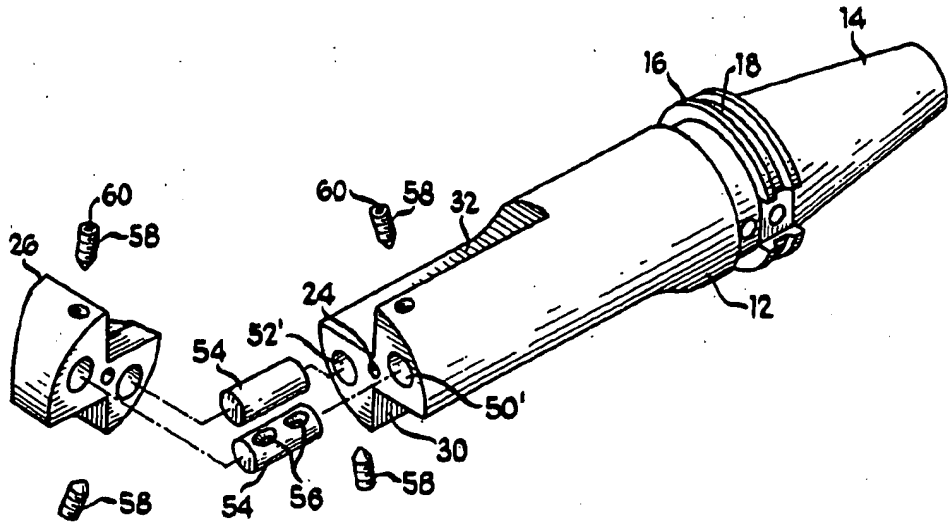
(54) Title: INSERT DRILL WITH REPLACEABLE END CAP



(57) Abstract: The insert drill (10) disclosed comprises a drill body (12) proper in which the entering hole-forming inserts (34, 36, 38, 40) are mounted in a removable and replaceable end cap (26) to facilitate restoration of the drill (10). The attachment of the end cap (26) to the drill body (12) is made by two sizable pins (54) received in aligned holes (50, 50', 52, 52') in the end cap (26) and drill body (12) and secured therein by set screws (58) engageable with holes (56) in the pins (54).

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INSERT DRILL WITH REPLACEABLE END CAP

In certain heavy-duty drilling operations, particularly of the automated kind, the dulling of the inserts at the entering end of the tool may go unnoticed for a sufficient length of time to effectively destroy the end of the tool as a result of excessive heating. For such applications, it would be desirable to make insert drills available with replaceable end caps in order to avoid the expense entailed in the loss of the entire tool, particularly in larger diameter drills.

Replaceable end caps have heretofore been used on end mills in severe service and typically have contemplated a cylindrical plug-and-socket coupling between the end cap and the body of the tool with multiple drive pins anchored in the tool body and received in holes in the end cap, an assembly maintained by a central cap screw threaded into the tool body through a counter-bored hole in the end cap.

Such arrangements do not lend themselves to drills, which are required to cut to the center of rotation and from which substantial amounts of the tool material must be removed from the end cap to provide the chip gullets necessary to allow the chips removed from the workpiece to be lifted or flushed from the hole.

In a typical drill with diametrically aligned cutting inserts on opposite sides of center, the residual end cap material between successive chip gullets is likewise disposed as diametrically opposed material masses which offer themselves as the only available attachment sites for coupling the end cap with the tool body.

It is the object of this invention to utilize those sites, together with coupling drive pins, to secure the end cap of the drill to the drill body against axial or rotational dislodgement by readily made connections which themselves are protected from the damage to which the end cap is exposed.

SUMMARY OF THE INVENTION

Axially alignable holes bored into the diametrically opposed masses of the end cap and into the drill body, respectively, parallel to the axis of rotation, each receive one end of a pin which spans the axially

perpendicular contact interface of the two members. Each pin has two axially spaced radial depressions in its surface, which are conical in form and disposed on the same side of the pin in the same axial plane thereof. The depressions are engageable by conical-nose set screws disposed perpendicular to the plane of the radius on which the holes of the end cap and drill body, respectively, are aligned. The set screws of the end cap and of the drill body, respectively, enter their respective host bodies from opposite directions in the same plane perpendicular to the rotational axis, while the set screws engaged with each pin are disposed in the same plane parallel to the rotational axis and spaced axially therein from the contact interface an aggregate distance slightly greater than the axial spacing of the depressions in the pins. Tightening the set screws into their respective pin depressions locks the end cap against rotation relative to the drill body and intensifies the interface contact force.

DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view of an indexable insert drill with replaceable end cap in accordance with the invention;

FIGURE 2 is an exploded perspective view of the drill of FIG. 1;

FIGURE 3 is a side elevation of the drill;

FIGURE 4 is a plan view of the drill as shown in FIG. 3;

FIGURE 5 is an end view, somewhat enlarged, of the drill as shown in FIG. 4;

FIGURE 6 is a rear elevation of the end cap with connecting pins in place therein;

FIGURE 7 is a front elevation of the drill body absent the end cap;

FIGURE 8 is a plan view of one of the two connecting pins used; and

FIGURE 9 is an end view of the pin of FIG. 8, partially broken away to show one of the set-screw receiving depressions of the pin.

DESCRIPTION OF PREFERRED EMBODIMENT

The drill shown in the drawing FIG. 1 is a fairly large drill 10 with a cutting diameter slightly in excess of three inches, an overall length of approximately fourteen and a half inches and an unsupported length of slightly over ten and a half inches when mounted in a machine spindle, not shown. As illustrated, the mounting end of the cylindrical drill body 12 is machined to provide an integral taper 14 and combination gripping and drive flange 16 with peripheral groove 18 for handling by an automatic tool changer and diametrically opposed notches 20 to receive the driving bar keys on the face of the spindle. The threaded end portion 22 (FIGS. 3 and 4) of a central bore 24 of the drill receives the usual gripper knob, also not shown, by means of which the tool is drawn tightly into the receiving taper of the spindle.

The central bore 24 extends throughout the drill body proper, and is extended into, and ends, in the end cap 26 at the free end of the tool. There it is joined by two lesser angular bores 28 which deliver to the cutting sites the cutting fluid introduced into the central bore through the machine spindle, and a central bore in the gripper knob.

In the illustrated embodiment the drill body 12 and end cap 26 are milled to provide a pair of diametrically opposed chip gullets 30 and 32 extending axially from the cutting face of the end cap 26 along the sides of the drill body 12. At the cutting face of the end cap each chip gullet is further milled to provide seats for indexable inserts 34, 36, 38, and 40, illustrated as four-edged square inserts of which two occupy each gullet. The cutting edges of all of the inserts are arrayed in a convex curve in the same diametrical plane, being staggered in radial displacement from the center of rotation so that the insert 36 of the gullet 32 cuts to the center as insert 40 of the opposing gullet 30 cuts to the periphery, the inserts collectively sweeping a continuous cutting path from the center of rotation to the periphery.

In the illustrated embodiment, a further insert 42, positioned in the chip gullet 30 of the tool body at a point removed from the end cap 26, is provided to take a boring finish cut in the hole formed by the through passage of the hole-opening inserts 34 to 40 of the end cap.

The drill body 12 and its end cap 26 meet at a planar interface 44 perpendicular to the rotational axis of the tool. The removal of material from both constituent parts of the tool to create the chip gullets 30 and 32 leaves the residual material in a configuration which, at their interface 44, resemble a bow tie (FIGS. 2 and 6), i.e., two diametrically opposed masses 46 and 48 of the end cap and their mirror-image counterparts 46' and 48' of the drill body 12, the masses of both constituent parts of the drill being rather more narrowly connected at the center of rotation.

Each of the masses of the end cap is drilled and milled in a smooth-bore hole 50 and 52 parallel to the rotational axis and in precise alignment with a like hole 50' and 52' in the drill body (FIGS. 6 and 7). The two holes of each constituent part are somewhat offset from precise diametrical alignment, as their opposed masses are slightly unequal in size owing to the larger cross-section of the chip gullet 32 of the insert 36 that is required to cut to center. Optimal placement of the holes in the opposed masses on opposite sides of center, which is to say, at the approximate centroid of each mass, and with centers at the same radius from center of rotation, results in a slight angular displacement of each from diametrical alignment with the other.

The holes in the end cap and drill body are aligned as pairs each of which receives a cylindrical connecting pin 54 of chrome steel alloy finish ground to an outside diameter providing four to six thousandths clearance on a three-quarter inch diameter. The length of the pin is approximately one-tenth of an inch less than the combined depths of each pair of aligned holes 50-50' and 52-52' of the drill body and end cap.

Each of the connecting pins 54 is provided with a pair of axially aligned and countersunk radial holes 56 on centers spaced a predetermined distance apart and at predetermined distances from each end of the pin. The holes 56 of the pins are disposed to permit each to receive à conical-nose, headless set screw 58 with drive socket 60 positioned in each of the end cap 26 and drill body 12 (FIG. 2). The set screws of drill body and end cap engageable with each pin are likewise in alignment with each other axially of the tool, with their center lines parallel to the interface

44 between their constituent bodies and perpendicular to a radius from the center of the pin to the center of rotation.

The predetermined distance of the two set-screw receiving holes 56 of the connecting pins is less than the distance between the two set screws 58 engageable therewith when the end cap 26 and drill body 12 are in contact at their interface 44, the set screw placements, for convenience of manufacture, being equidistant from that interface. The spacing of the holes 56 of the pins 54 and of the set screws 58 engageable therewith is preferably such as to provide a maximum available draw "D" (FIG. 8) of approximately twenty-five thousandths inches. This is more than sufficient to maintain the end cap 26 in solid contact with the drill body 12 at their interface 44, a contact maintained by the resilient distortion of the set screws after the thread clearances are taken up, and the conical noses of the set screws become tightly engaged with the countersunk surfaces of the holes 56 in the pins.

As it is contemplated that the connecting pins 54 will first be secured in the drill body 12, and the set screws 58 thereof firmly engaged in the associated holes 56 in the pins 54, the depth of the pin-receiving holes 50' and 52' of the drill body 12 is some twenty-five thousandths greater than required to align the set screws thereof in the associated holes of the pins. The pin receiving holes 50 and 52 of the end cap 26 are deeper by fifty thousandths than the exposed lengths of the pins when seated in the tool body in order to allow for the unrestricted draw of the end cap into tight engagement with the drill at their interface without bottoming the pin 54 in the hole 50 or 52 of the end cap.

With the set screws tightly engaged from opposite directions with their respective connecting pins, the clearances of the pins in their respective holes in both bodies is taken up, and the end cap 26 thereby secured against rotation relative to the drill body 12 under the heavy torque experienced in a drill of the indicated size. The differential spacing of the conical set screws 58 and their associated countersunk holes 56 in the connecting pins serving at the same time to draw the end cap and drill body tightly together at their interface 44 so as to constitute them the equivalent of a unitary drill tool.

The features of the invention believed new and patentable are set forth in the appended claims.

What is claimed is:

1. An insert drill with replaceable end cap comprising:

a generally cylindrical tool body having one end thereof adapted for driving rotation on the cylindrical axis by a machine tool spindle and the opposite end adapted for coupling in driving relation with a removable end cap;

a removable end cap in facing contact with said opposite end of the tool body on a plane perpendicular to the cylindrical axis thereof;

said end cap and tool body being formed to provide multiple chip gullets in extension of each other;

each chip gullet of the end cap being formed to receive at least one replaceable cutting insert positioned radially thereof to share a radially continuous collective cutting path from the center of rotation to its periphery with the at least one insert of each other end-cap gullet;

said tool body having protruding axially therefrom at said plane of contact multiple drive pins of like number as said chip gullets received in holes formed in said end cap body parallel to and displaced radially from the axis of rotation and positioned rotationally between successive chip gullets thereof; and

set screws in said end cap each positioned therein for locking engagement with one of said drive pins of the tool body to secure the end cap in facing contact with said tool body and rotationally immobile with respect thereto.

2. The insert drill of claim 1 wherein the chip gullets of said end cap and tool body are two in number, and the cutting inserts are at least two in number per gullet aligned diametrically with those of the other gullet and spaced from each other in radially staggered relation to those of the other gullet so as collectively to sweep said radially continuous cutting path.

3. The insert drill of claim 1 or 2 wherein the drive pins protruding from said tool body are likewise each seated in a conforming hole in the tool body axially perpendicular to said plane of contact and

secured therein by a set screw in the tool body engaged therewith , the set screws of end cap and tool body, respectively, engaged with a given drive pin being disposed in the same plane and accessible from the exteriors of said bodies, and each having at its engaging ends a conical camming surface engageable with a like hole in the surface of its associated pin to urge the pin more deeply into the associated holes in the two bodies, thereby to pressurize the facial contact between the two bodies when the set screws are tightened, and to secure the two bodies against relative rotation.

4. The insert drill of claim 3 wherein the depressions of a given drive pin are spaced more closely than its associated set screws of the end cap and the tool body.

Fig 1

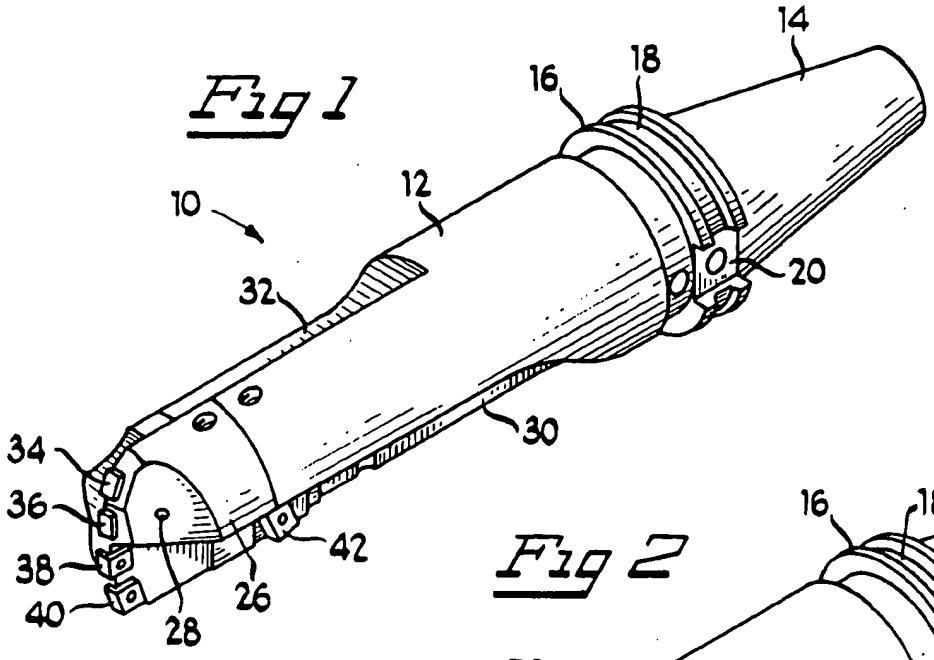


Fig 2

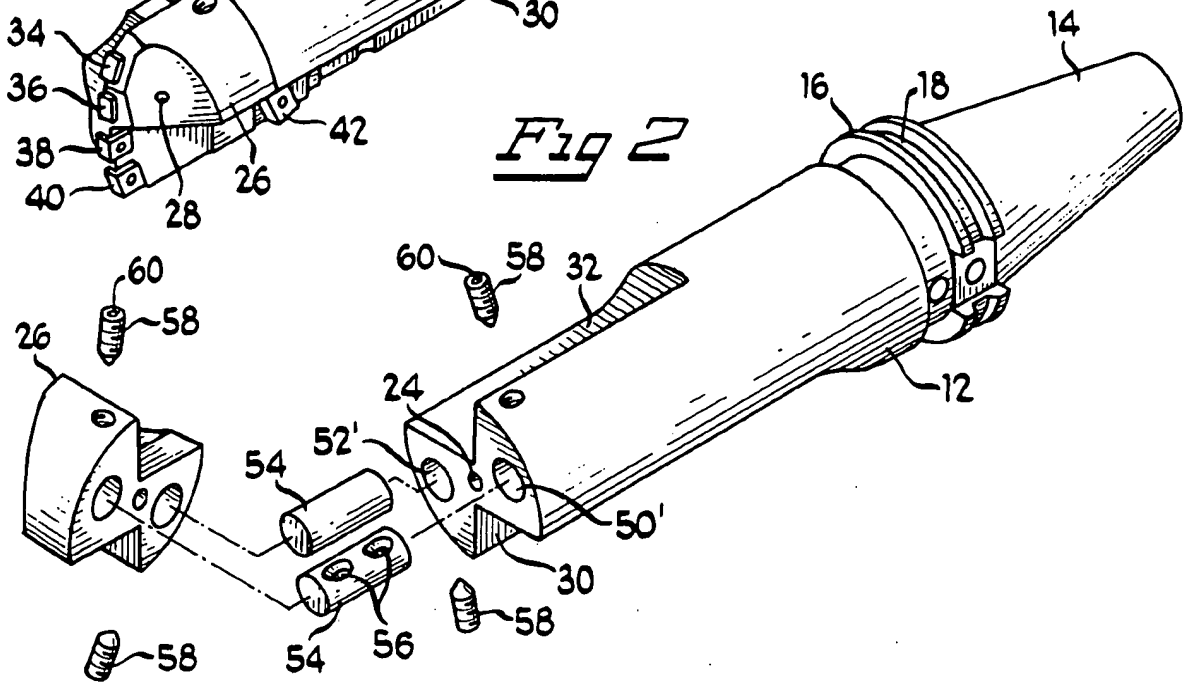


Fig 8

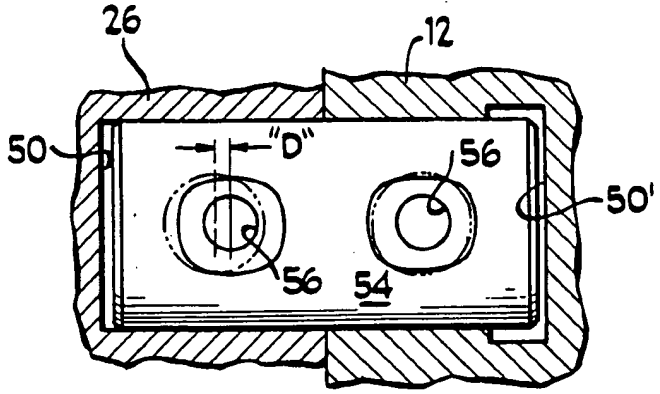


Fig 9

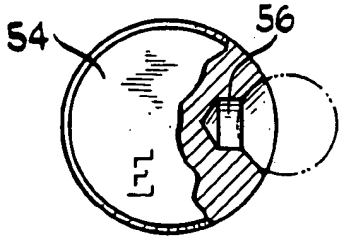


Fig 3

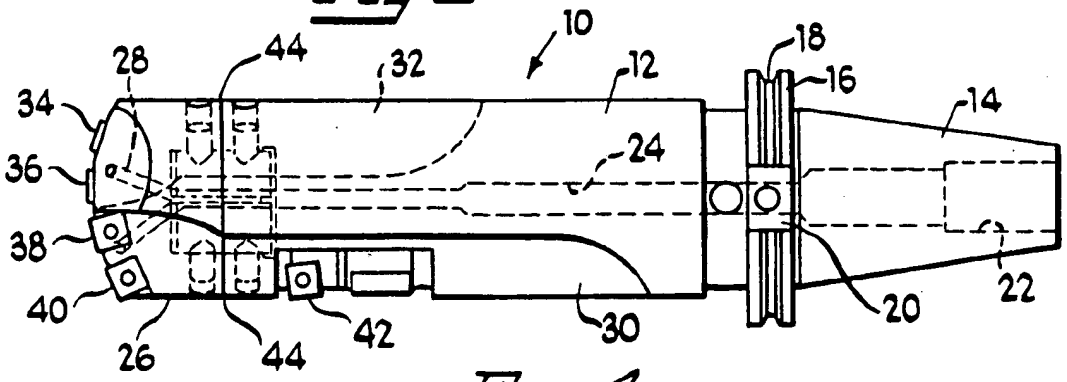


Fig 4

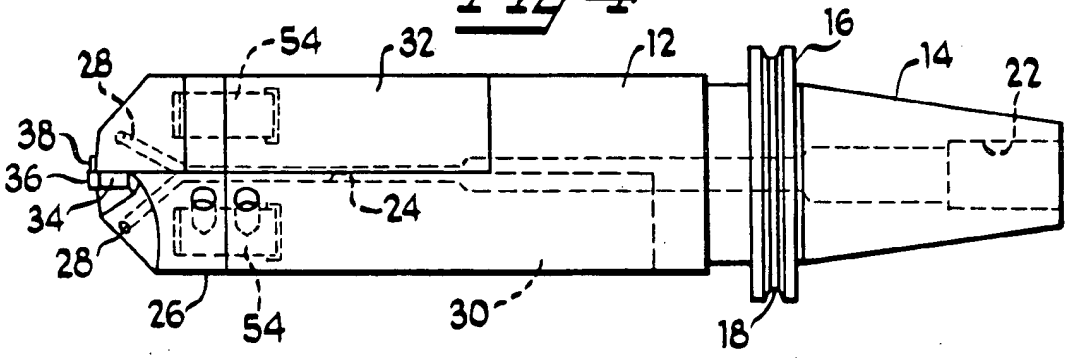


Fig 5

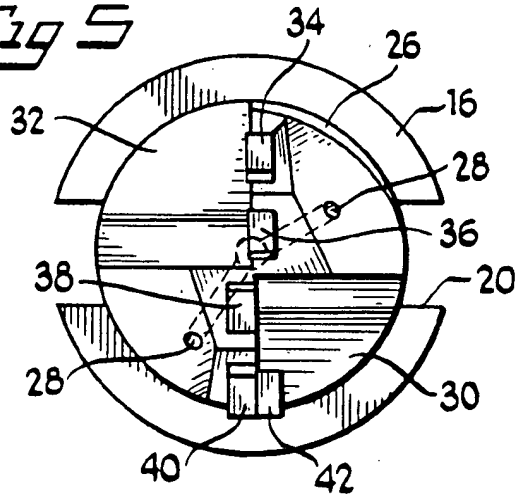


Fig 6

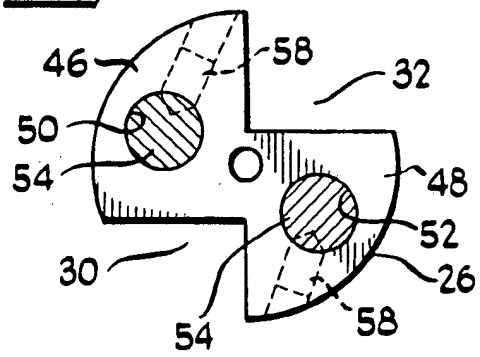
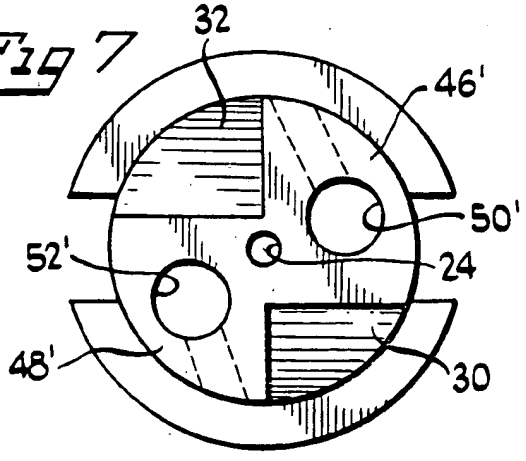


Fig 7



INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B23B 51/02
US CL :408/227, 231, 233, 713

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 408/144, 223, 224, 227, 229, 230, 231, 233, 239R, 713

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, 4,684,298 A (ROOS) 04 August 1987, see figures 1-3	1
A	US 4,856,944 A (REINAUER) 15 August 1989, see figures 1-4	1
A	US 4,950,108 A (ROOS) 21 August 1990, see figures 1-4	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DANIEL W. HOWELL Telephone No. (703) 308-1148

Sheila Veney
Paralegal Specialist
Technology Center 3700